



# Script concordance test: Insights from the literature and early stages of its implementation in osteopathy

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**Abstract** Osteopathic pre-registration education aims to produce competent autonomous practitioners who are capable of dealing with and mastering the uncertainty of clinical practice. The students' preparedness for clinical practice is typically assessed using high fidelity long case exams, i.e., clinical competence assessments using real patients in a real clinical setting. In this paper, we critically review relevant literature concerning the validity, reliability and underpinning educational theory of the Script Concordance Test (SCT), and describe the development, implementation and initial critical evaluation of this assessment tool in the osteopathy programme at Oxford Brookes University. The SCT is an assessment tool aimed at assessing clinical reasoning in the context of uncertainty, which is being increasingly used as an assessment strategy in the field of medical education. Despite its limitations, we believe that the SCT is a useful addition to assessing clinical reasoning in osteopathy, particularly in situations of clinical uncertainty. It has the potential to effectively assess the students' diagnostic reasoning, evaluation of risk and patient safety, and ethical aspects of osteopathic care. Critically, it provides an important vehicle to assess the students' preparedness for autonomous clinical practice using a standardised format.

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## Introduction

In the UK, osteopaths operate as primary contact practitioners and follow a four or five-year academic programme of study. At the point of graduation, students are required to possess a clinical competence profile which enables them to effectively operate as autonomous health care practitioners. This competence profile is reflected on a well-developed clinical reasoning. Clinical reasoning is widely recognised as the essential element for competent autonomous health care practice.<sup>1,2</sup> Notwithstanding this, clinical reasoning is a complex process occurring within a multidimensional context. It provides the integrative element between knowledge, cognition, and metacognition, which enables clinicians to take the best-judged action in situations of clinical uncertainty.<sup>1,3</sup> The assessment of clinical reasoning plays, therefore, a central role in pre-registration osteopathic education. Typically, students' clinical reasoning capabilities are assessed using high-fidelity long case exams, i.e., clinical competence assessments using real patients in a real clinical setting, and multi-station assessments such as Objective Structured Clinical Examinations (OSCE). In osteopathy, in particular, the assessment of clinical competence is heavily reliant on the use of the long case exams.<sup>4</sup>

Despite the wide use of long case exams in the assessment of clinical competence in medicine and osteopathy, an analysis of the literature concerning their reliability and validity highlights mixed results.<sup>5–8</sup> Improvements in their validity and reliability are achieved with the use of trained assessors and standardised assessment criteria,<sup>8</sup> and when two or more cases per candidate are used.<sup>5</sup> It has recently been demonstrated considerably higher reliability for a 4-h long case exam (0.86) compared to a single long case exam (0.32).<sup>9</sup> Attempts to ensure that the long case exam in osteopathy is a valid and reliable tool have been made. Strategies widely employed by osteopathic education establishments in the UK include the training of assessors and the use of two or three patients per candidate. Notwithstanding this, issues such as a limited range of clinical presentations and the examiners' biases toward analytical reasoning strategies (e.g., hypothetico-deductive reasoning) pose a potential threat to the validity and reliability of long case exams conducted in real clinical settings. On this latter point, evidence from our research demonstrates that some of the cognitive strategies employed by expert clinicians and students at the point of graduation are in fact similar.<sup>10,11</sup> Differences in

their clinical reasoning process are primarily related to their knowledge representation. Therefore, it can be argued that students may fail to provide an appropriate account of their patient's problem, if examiners conduct assessments in a way that forces them to utilise analytical reasoning strategies in situations of familiarity. We would argue that a more valid and reliable way of assessing clinical reasoning and clinical competence would include a combination of real patients in real clinical settings and computer-based case scenarios, which are specifically developed and piloted to the various stages in the pre-registration programme.

The aim of this paper is two-fold. Firstly, we critically review relevant literature concerning the validity, reliability and underpinning educational theory of the script concordance test (SCT). Secondly, we describe the development and implementation of the SCT in the osteopathy programme at Oxford Brookes University, and provide a summary of feedback obtained from a student evaluation conducted in the academic year 2011/2012. Whilst appraising the literature and reflecting on the implementation of this assessment strategy, we critically evaluate the strengths, challenges and potential limitations of the SCT in osteopathy. It is, however, beyond the scope of this paper to provide an in-depth analysis of this assessment's validity and reliability. This analysis will occur at the end of the current academic year and will be reported in a future research article.

The SCT is an assessment tool aimed at assessing clinical reasoning in the context of uncertainty, which is being increasingly used as an assessment strategy in the field of medical education.<sup>12–14</sup> Several studies have reported that the SCT has excellent validity and reliability.<sup>12,15–20</sup> The SCT is based upon an adaptation of the cognitive psychology script theory. The script theory provides the basis for a dynamic model of memory, in which all memory is episodic, and organised in terms of scripts.<sup>21</sup> According to this conceptual framework, real-life events are understood in terms of scripts, plans, and meaningful previous experiences. As a result of their exposure to real patients in clinical practice, the practitioners' knowledge becomes re-organised into narrative structures commonly referred to as 'illness scripts'.<sup>22</sup> These narrative structures contain three important components: (1) enabling conditions of the disease, (2) the fault of the disease regarding pathophysiological process taking place, and (3) the consequences of the fault which are the signs and symptoms of the

disease.<sup>23,24</sup> Schmidt and Rikers argue that these structures contain significant amounts of information about the enabling conditions to the onset and progression of particular clinical diseases or syndromes. This information, which is primarily gained through exposure to patients in clinical practice, enables clinicians to rule out unlikely diagnostic categories and to focus on those that are most likely. The results from our own research in osteopathy are in line with the views of Schmidt and colleagues and demonstrate a link between the development of professional expertise and the process of knowledge re-organisation and script formation.<sup>10,11</sup> We would therefore argue that the SCT is a useful addition to assessing clinical reasoning in osteopathy, particularly in situations of clinical uncertainty.

## The development and implementation of the SCT at Oxford Brookes University

The SCT was implemented as a summative assessment strategy at Oxford Brookes University (OBU) on their Master of Osteopathy (MOst) in 2011. In support of its implementation in the osteopathy programme, it was reasoned that the test would enable academics to assess the final year students' ability to effectively operate in situations of clinical and professional uncertainty. Rather than being an alternative to the long case exam, the SCT would be an important complementary strategy. Critically, we believe the SCT is effectively aligned with the educational philosophy of the programme. In their clinical education, students are initially given the opportunity to experience familiar problems within familiar situations. As their competence profile develops, they are confronted with unfamiliar problems in familiar and controlled situations, and finally they are exposed to unfamiliar problems in unfamiliar contexts. The osteopathy programme aims to produce competent autonomous practitioners who are capable of dealing with and mastering the uncertainty of clinical practice. To our knowledge, this was the first use of the SCT in osteopathy. Six students completed the assessment in the academic year 2010/2011, followed by 17 students in 2011/2012. In this section, we describe the nature of the test, the development of cases and questions, the selection of the expert panel and the development of its marking scheme. Moreover, we provide a summary of feedback obtained from a student evaluation conducted in the academic year 2011/2012.

The construction of the SCT involves two or more experienced clinicians writing clinical scenarios, suggesting a hypothesis and introducing additional clinical information. This assessment is

based on three principles, each concerned with one of the following three components: students are presented with a series of tasks, which represent authentic clinical situations and are described in vignettes. Each vignette does not contain all the data required to provide a solution and several options (e.g., diagnosis, management) should be considered; students are required to make a judgment based upon the limited available clinical information, using a Likert scale. Students have to decide whether the new information makes the hypothesis much less likely, less likely, ineffectual, more likely or much more likely (see Fig. 1).<sup>12–14</sup> Each of these judgments can be measured and compared to those of a reference panel of experienced practitioners. Credits for each question are derived from the answers given by the panel of experts and divided by the number of panel members, scores for each question are added up and divided by the total number of questions and divided by 100 to give a percentage score.

### Construction of questions

In the development of the SCT, we used a case based approach following recommendations by authors such as Fournier and colleagues, who have argued that such approach makes the test more relevant to problems posed in clinical situations.<sup>13</sup> Two experienced osteopaths with more than 15 years in clinical practice were selected to develop the clinical scenarios based on real clinical scenarios from practice. Fournier et al. suggested that an important consideration for its validity is that the SCT covers the area of clinical practice under consideration.<sup>13</sup> To this end, cases were developed taking into account the types of clinical presentations commonly seen by UK osteopaths.<sup>25</sup>

The SCT was developed and administered in an electronic format, which had the advantage of ease of construction and application. In the first student cohort sitting the assessment, answers were made electronically but marking was conducted by mixture of electronic and manual methods. Taking into account the small number of students, it was reasoned that that an analysis of each data set would assist with student feedback. For the second student cohort, however, marking was increasingly electronic with some manual analysis undertaken. A mainly electronic approach will be favoured in the development of this year's SCT.

### Expert panel

The number of experts used must be sufficient to express the variability in answers between experts,

**Clinical vignette**

*Patrick is a 39 year old builder complaining of left low back pain radiating into his left buttock and posterior thigh.*

- a) If you were thinking of a left posterolateral disc herniation and note on observation that he is side shifted to the right.**

This hypothesis becomes				
1	2	3	4	5

Scoring key: 1 = much less likely, 2 = slightly less likely, 3 = neither more nor less likely, 4 = slightly more likely, 5 = much more likely.

- b) Patrick informs you that his brother recently had a back operation.**

This hypothesis becomes				
1	2	3	4	5

Scoring key: 1 = much less likely, 2 = slightly less likely, 3 = neither more nor less likely, 4 = slightly more likely, 5 = much more likely.

- c) Examination reveals a positive Straight Leg Raising test at 55 degrees on the left side reproducing his left leg symptoms; compression is negative but he does not like to slump as he feels apprehensive.**

This hypothesis becomes				
1	2	3	4	5

Scoring key: 1 = much less likely, 2 = slightly less likely, 3 = neither more nor less likely, 4 = slightly more likely, 5 = much more likely.

**Fig. 1** Example of SCT clinical vignette.

with various authors suggesting numbers ranging from 5 to 26.<sup>12,13,26</sup> Humber and colleagues argued that a minimum of 15 panel members (expert clinicians) is required in high-stake examinations to obtain acceptable reliability estimates.<sup>27</sup> Moreover, Fournier and colleagues found that reliability estimates improve with larger panel sizes; however, improvements are only marginal when panels have more than 20 experts.<sup>13</sup> Considering that the SCT at OBU forms part of the final year clinical assessments, we regarded this assessment as a high-stake exam and therefore, a high level of reliability was needed. Twenty expert clinicians were therefore recruited; this number would avoid overspending whilst ensuring appropriate reliability. Experts were selected from a pool of clinical competence assessors and from a range of osteopathic education institutions in the UK; they were all recruited by email but anonymity was ensured. All had been in clinical practice for a minimum of 8 years and in osteopathic education for a minimum of 5 years.<sup>10</sup> Recruitment took into consideration gender balance and cultural background. The university guidelines on equal opportunities and diversity require gender equality in the implementation of assessment procedures. Panel lists represented cultural backgrounds; however, as all of them were educated in the UK, diversity may have been compromised. On this point, Aldekhayel et al. looked at the validity of SCT answers in the field of plastic surgery with panel lists from Canada and

Saudi Arabia, and concluded that although they a high variance between Canadian and Saudi Arabian reviewers was observed, intra-group responses were more homogenous.<sup>28</sup> The authors hypothesized that the observed difference in responses may be attributed to language or cultural factors. In the UK, osteopaths are required to be aware of their patients' specific needs in relation to gender, ethnicity and culture.<sup>29</sup> At OBU, students are required to show cross-cultural awareness and work effectively in a global context. On reflection, we acknowledge that a more diverse panel may achieve greater exposure to cultural diversity thus ensuring enhanced validity of the marking scheme in a global context.

Panel lists were instructed to complete the test online during a pre-determined week. They were informed that no prior preparation was needed. Guidelines recommend the SCT to be completed within one hour and that no textbooks or other sources of information are used.<sup>13</sup> In 2011, only 11 of the 20 recruited experts completed the questions in the required timeframe, with potential adverse effects on the reliability of the first student cohort results. For the second student cohort, the number of experts completing the SCT improved as a result of several adjustments made. These adjustments, which were based on received feedback, included the provision of appropriate notice; a reasonable timeframe within which test had to be completed (1 week); and an additional

number of 'back up' experts who could be used in the event of illness or unforeseen circumstances by which the expert was not available to complete test within the required timeframe.

### The marking scheme

The scoring of the test is achieved by giving the student credit for each answer expressed as a percentage of the total number. For example, if there were fifteen experts on a panel, the mark for the question would be the model value divided by the number of panel lists, i.e., if only one expert chose an option and the student chose this option they would achieve a mark of  $1/15 = 0.06$ . Scores obtained on each question are added to obtain a total score. This number is then divided by the number of questions and multiplied by 100 to achieve a percentage score.<sup>13</sup>

### Student evaluation

To evaluate the effectiveness and usefulness of the newly implemented clinical reasoning assessment, student evaluation was conducted through a questionnaire composed of three questions – (1) the script concordance test is a useful way of assessing clinical reasoning over a wide range of topics; (2) the use of 20 experts rather than one correct answer makes the assessment more closely related to clinical practice; (3) I feel that the script concordance test is a useful addition to assessing osteopathic practice.

Questionnaires were sent to all 17 students in the final year of the M.Ost programme. From a total of 17 distributed questionnaires, 76% (13) were completed and returned. Results from the evaluation demonstrate that 31% of the students strongly agreed and 69% agreed with the SCT's usefulness in assessing clinical reasoning. Concerning the use of a panel of 20 experts, 38% of the students strongly agreed and 62% agreed with the statement. Finally, 31% of respondents strongly agreed and 62% agreed that the SCT is useful addition to the assessment of osteopathic practice. One student (7%) disagreed with statement. Taken together, the results from our preliminary evaluation demonstrate that students consider the SCT to be a useful and effective way to assessing clinical reasoning.

### Critical evaluation of the SCT and future development

Although we argue that the SCT is a useful addition to assessing osteopathy students' ability to operate in

situations of clinical uncertainty, we are nonetheless aware that its underpinning theory has received some criticism in the literature. For example, Jones and Rivett claim that the concept of illness scripts "probably oversimplifies the complexity of a clinician's organised knowledge".<sup>30,p.12</sup> These authors assert that every characteristic of a patient's presentation (enabling conditions, fault, and consequences of the fault) lie within a continuum, which may or may not be relevant, and practitioners must therefore possess a broad understanding of the determinants of health and recovery as well as 'sifting out' the most dominant clinical features.<sup>30</sup> Further challenges come from Patel and colleagues, who are sceptical and argue against the concept of knowledge encapsulation proposed by Schmidt and co-workers.<sup>31–34</sup> Kauffman et al. claim that "the notion of knowledge encapsulation represents an idealised perspective of the integration of basic sciences in clinical knowledge".<sup>32,p.146</sup> This argument maintains that rather than an integrated world of biomedical sciences subsumed under clinical knowledge, that clinical medical knowledge and biomedical sciences are two distinct worlds, and play separate roles in the reasoning process.<sup>32</sup> They explain that while the script theory may account for the reasoning through of non-complex cases, experts will have to generate new causal models, based on the biomedical sciences and pathophysiology for presentations which have not been previously encountered.<sup>32</sup> Studies support the view held by Patel and colleagues, suggesting that the biomedical science is the primary and essential source of knowledge for diagnostic classification, while other research supports knowledge encapsulations and case representation.<sup>35–37</sup> We have recently found evidence that in the development of diagnostic expertise in osteopathy, both biomedical knowledge and the knowledge of osteopathic models of diagnosis and care become encapsulated into clinical knowledge. Notwithstanding this, biomedical knowledge remains strongly represented in the clinician's long-term memory.<sup>10</sup>

Owing to the basic assumption of cognitivism, that the mind can be viewed as operating like a computer, a major limitation of cognitivist approaches to assessing (and researching) clinical reasoning is that it only propositional knowledge which can be sufficiently verbalised can be recognised, i.e. knowledge which is explicit and can be readily verbalised.<sup>38</sup> The result is that the SCT can only provide a superficial and one-dimensional understanding of clinical reasoning and therefore concepts such as artistry, wisdom and tacit knowledge are effectively undetectable to cognitivist methods. While the model of knowledge acquisition provided by Schmidt et al. provides a useful framework for the development of

diagnostic expertise in medicine it may have limited transferability to osteopathic practice.<sup>34,39,40</sup> If future practitioners are to embrace patient-centred reasoning and practice, then clinical reasoning must include more than just efficient diagnostic scripts, but rather include 'treatment scripts' and 'patient scripts' in order for the complexities of practice and the individualities of practice can be recognised.<sup>41</sup>

Another issue which should be considered is 'what' the SCT intends to measure. Measuring students reasoning on the basis of their answers related to a complete or partially completed case vignette (with details of the patient and health problem) is unlikely to capture the complex process of clinical reasoning which occurs throughout the patient-practitioner encounter. The SCT may tend to narrowly assume that the clinicians' main objective is to find and solve problems, by formulating diagnoses and differential diagnoses, with little regard to the treatment and management aspects of the patient. The script theory posited by Schmidt et al. emerged during a period in health care when the emphasis was on the disease, rather than the patient with the disease.<sup>39,42</sup> Research into health professions over the past 25 years has vastly expanded upon the early descriptions of clinical reasoning, in line with contemporary models of health and disability.<sup>43,44</sup> Furthermore, research has shown clinical reasoning to be a dynamic process, which occurs throughout the patient encounter, and moves beyond the point of diagnosis formation.<sup>45–48</sup> In light of these issues, the SCT may be too centred on diagnosis formulation, in order for it to be seamlessly transferred to osteopathy.

An additional issue which requires consideration is the nature of expertise and what constitutes an 'expert'. When devising a SCT for use to assess clinical reasoning capabilities, an 'expert panel' is selected to devise the clinical scenario and agree on answers.<sup>12</sup> However, the term 'expert' itself is somewhat problematic and there is no single consensually agreed definition. For example, Holyoak considers an 'expert' as someone capable of doing the right thing at the right time.<sup>49</sup> In contrast, Rothstein comments that "the expert as the practitioner known to achieve the best outcome...and that if an expert is not clinically more successful – then what's the point?"<sup>50</sup> When considering the latter view, it would appear that one ultimate purpose of developing expertise or 'being an expert' is to enhance care and achieve better patient outcomes. However, there is limited evidence to support the relationship between clinical reasoning expertise and enhanced clinical outcome. Other criteria may be used to designate an 'expert' panel are: peer recognition/nomination (practitioner

reputation),<sup>51,52</sup> years in practice (experience),<sup>53–56</sup> and academic achievements.<sup>45,47</sup> However, while these criteria may be a prerequisite for expertise, there have been criticisms of them all,<sup>57</sup> and little research exists to demonstrate that they lead to better clinical results.<sup>58,59</sup> Notwithstanding the preliminary evidence from our ongoing research, the way in which these criteria relate to osteopathy and what constitutes osteopathic expertise is largely unknown and warrants research.<sup>10,42</sup>

Despite the criticisms concerning its underpinning theory and the underdeveloped nature of research into osteopathic expertise, the SCT is a valid tool for assessing clinical reasoning in real-life clinical situations in medicine.<sup>12,15–20</sup> Data from the initial stages of its implementation at OBU are, however, too scarce to enable us to establish its reliability and validity. Research needs to be conducted in order to investigate whether it has this predictive power for osteopathy. The test has been suggested to be a useful tool to predict the readiness of medical students for clinical practice.<sup>27,60</sup> On this point, Humbert et al. concluded that the SCT successfully differentiates pre-clinical medical students from fourth year medical students.<sup>27</sup> In osteopathy, the SCT may also be a useful tool to predict the suitability of osteopathic students to enter clinical practice, as osteopathic pre-clinical students are in a similar position to medical doctors of needing to prove readiness to deal with real clinical situations when entering the teaching clinics. This is especially important in the context of ensuring an ability to make clinical decisions based on a broad range of clinical data. If SCT test is to be used in osteopathy to help predict the suitability of pre-clinical students to enter clinical practice, an accepted scoring level has to be set for these students.

The development of questions was based on data from the surveys of clinical presentations in osteopathic practice in the UK to ensure that an appropriately broad range of scenarios was included.<sup>25</sup> Questions and scenarios were proof read by the reviewers as a means of verifying the quality of the wording and the relevance of the questions.<sup>13</sup> Notwithstanding this, some typing errors were still evident. This may suggest that a greater number of proof readers are needed. It is plausible that reviewing team's workload did not enable them to spend enough time proof reading the test. Aldekhayel et al. suggested that greater validity of questions could be achieved by introducing a number of validation factors including relevance to training programme objectives; structural quality of test questions; written clarity of questions; cultural sensitivity; and plausibility

of provided options.<sup>28</sup> The three initial recommended items were addressed by the reviewers; however, no quality control was applied in terms of cultural sensitivity or plausibility of provided options. Moreover, Aldekhayel et al. argued that exclusion criteria should be applied to any item with a median range of 4.<sup>28</sup> This would require an initial construction of a greater bank of questions where some would be discarded after panel have completed the test. This is an aspect of the SCT's further development that are currently evaluating.

Despite the challenges associated with the implementation of a new assessment strategy and potential limitations of the SCT in the context of osteopathy, student feedback was largely positive even from the first cohort. In particular, students considered that when compared to OSCEs and the long case exam, the SCT provides a more in-depth form of assessment. Students reported that they understood the concept of uncertainty better because even experts have different opinions. The high level of student satisfaction may be attributed to the fact that this assessment was written into the curriculum from its validation; therefore, despite them not having previously completed an SCT, the exam did not represent a change in assessment. In the field of medicine, Duggan and Charlin reported mixed student feedback with the majority of students appreciating the 'real-life' depiction of scenarios and the relevance to their clinical practice; however, the majority of the students found it difficult to adapt to the new method of assessment.<sup>61</sup> The authors recommend the introduction of the SCT earlier in the programme to enable students to become familiar with the assessment. Although the SCT is only used in the final year of the osteopathy programme at OBU, we provided students with the opportunity to become familiar with the format and nature of this exam through formative assessments and in-class discussions. This approach may have contributed to the students' positive experience.

## Conclusion

Despite its limitations, we believe that the SCT is a useful addition to assessing clinical reasoning in osteopathy, particularly in situations of clinical uncertainty. Although the SCT does not assess clinical competencies such as patient examination and the ability to adapt treatment and management, it is nevertheless an important adjuvant to the long case exam. It has the potential to effectively assess the students' diagnostic reasoning, evaluation of risk and patient safety, and ethical aspects of osteopathic care. Critically, it provides

an important vehicle to assess the students' preparedness for autonomous clinical practice using a standardised format. Notwithstanding this, the SCT's reliability and validity need to be determined before its wider use in osteopathy.

## Statement of competing interests

JEE is a member of the International Advisory Board of the Int J Osteopath Med but was not involved in review or editorial decisions regarding this manuscript.

## Author contributions

JEE and MB developed and implemented the assessment tool. JEE and OPT drafted the article; all authors approved the final version.

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